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Propellant Savings during Soyuz Undock from the International Space Station

As a vehicle continuously orbiting Earth for over a decade, the International Space Station (ISS) must be conscious of ways to conserve consumables to maximize the efficiency of cargo flights to ISS. One such consumable is propellant. As part of an ongoing effort to minimize propellant usage onboard ISS and use control moment gyroscopes as much as possible for ISS control, an effort was made in late 2014 to allow Soyuz manned vehicle undockings without requiring the use of thrusters. This method, which has been used for four Soyuz undockings, saves up to 160 kg of propellant each year.

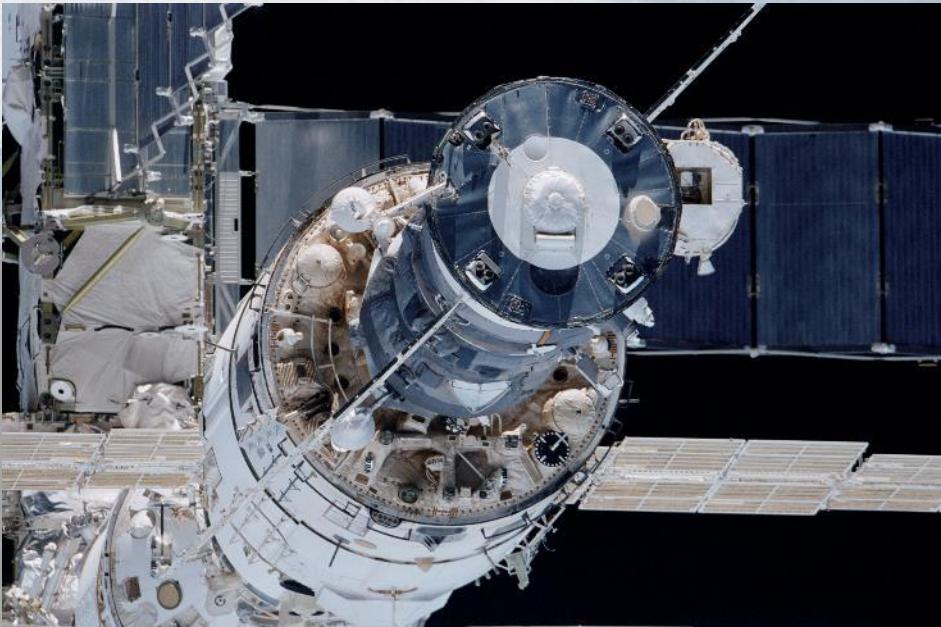
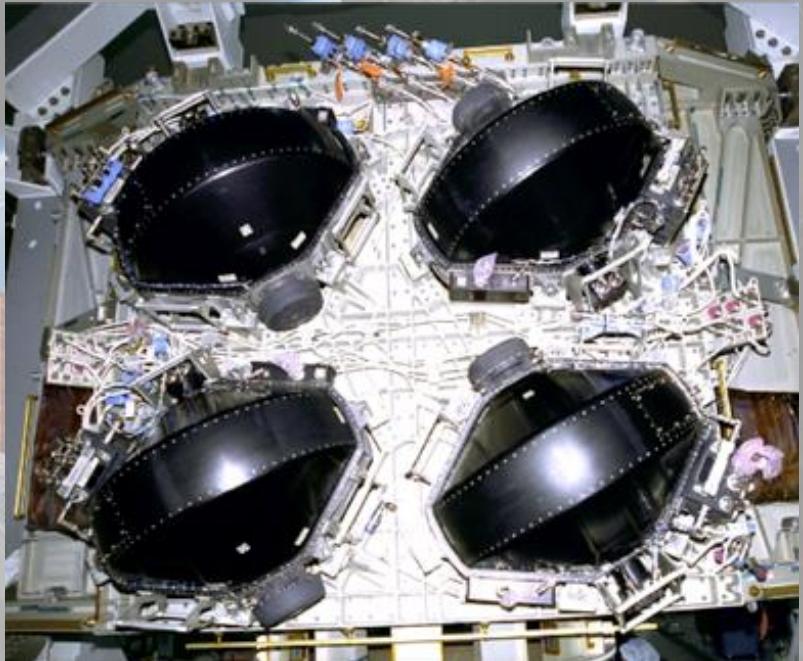
Fiona completed a B.S. in Mechanical Engineering at Washington University in St. Louis in 2009, after which she moved to Houston, TX to begin working at NASA Johnson Space Center. She currently works in the Flight Operations Directorate as an ADCO (Attitude Determination and Control Officer) flight controller and MCG (Motion Control Group) instructor. Her responsibilities include operating the motion control systems of the ISS in Mission Control, interfacing with Russian colleagues, mentoring and teaching flight controller trainees, and training astronauts for their missions to ISS.

A photograph of the International Space Station (ISS) in orbit. The station's complex structure of solar panels and modules is visible against the dark void of space. In the foreground, the circular hatch of a Soyuz spacecraft is prominent, with the word "COOL" visible on its side. The Earth's blue oceans and green continents provide a stark contrast to the metallic structures of the space station.

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ISS Attitude Control Options



Control Moment Gyroscopes

- Limited control authority
- No propellant required

Thrusters

- Much higher control authority
- Requires propellant

CMG Advantages

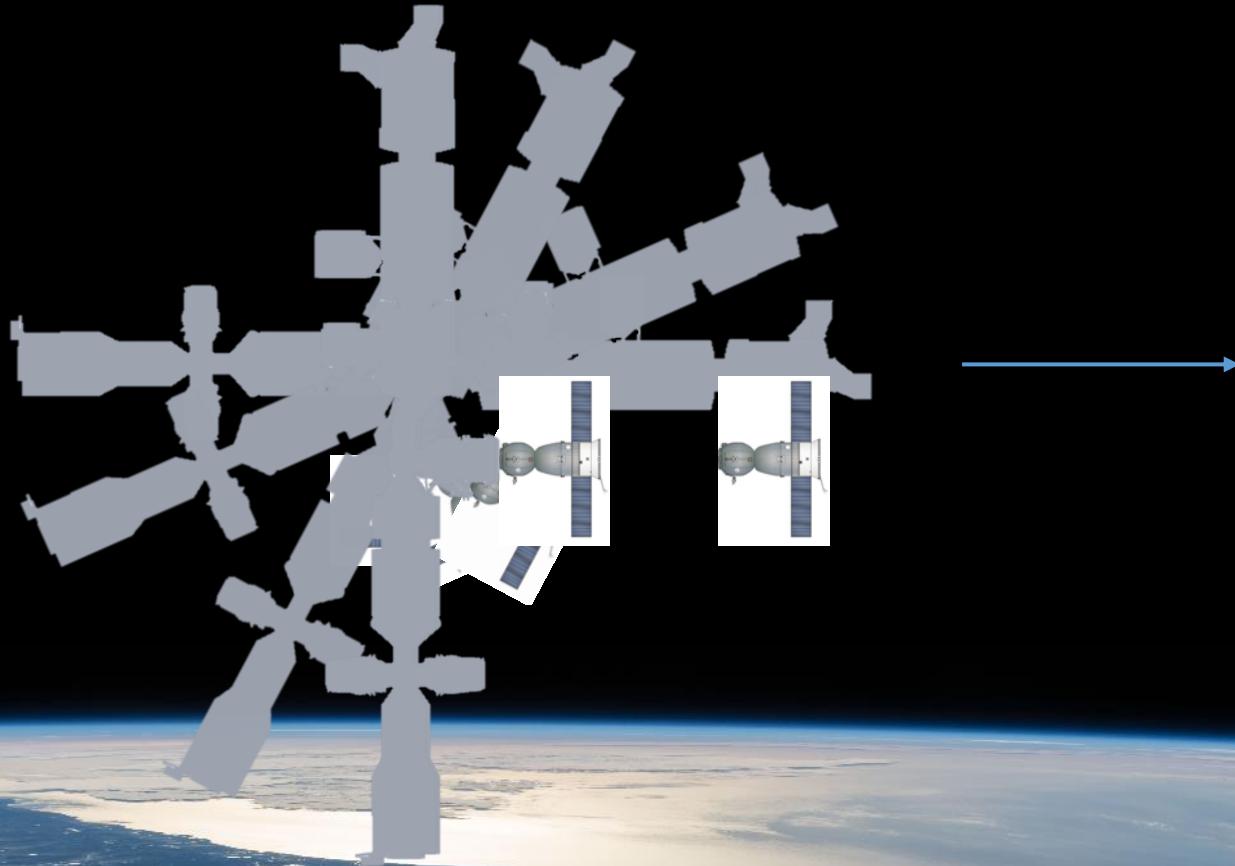
- No loading or contamination concerns
- No consumables required



Traditional Soyuz Undocking

- Timeline
 - Park solar arrays
 - Hand over attitude control from U.S. CMGs to Russian thrusters
 - Maneuver to undocking attitude
 - ISS to Free Drift for Soyuz undock
 - Recover ISS attitude control following undock
 - Maneuver back to nominal orbit attitude
 - Hand over attitude control from Russian thrusters to U.S. CMGs
 - Return solar arrays to nominal configuration

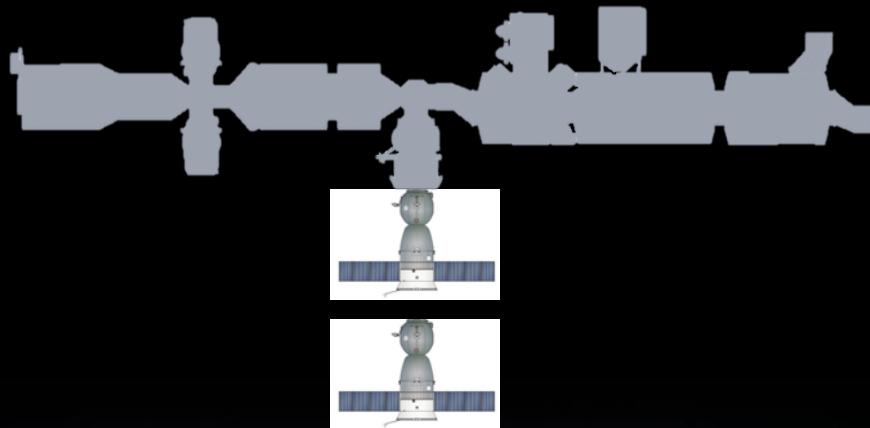
Traditional Sovuz Undocking



Soyuz Undock on CMG Control

- Timeline
 - Park solar arrays
 - Configure attitude control system for undocking and post-undock control
 - Soyuz undock
 - Automatic change to control mode allowing thruster assist
 - Return solar arrays to nominal configuration

Soyuz Undock on CMG Control



Propellant Usage

- Traditional Soyuz Undock: 10-40 kg
- Soyuz undock on US Control: 0-1 kg
- Savings per year (4 Soyuz/year): 40-160 kg

